



State of CERES



Norman G. Loeb

NASA Langley Research Center, Hampton, VA



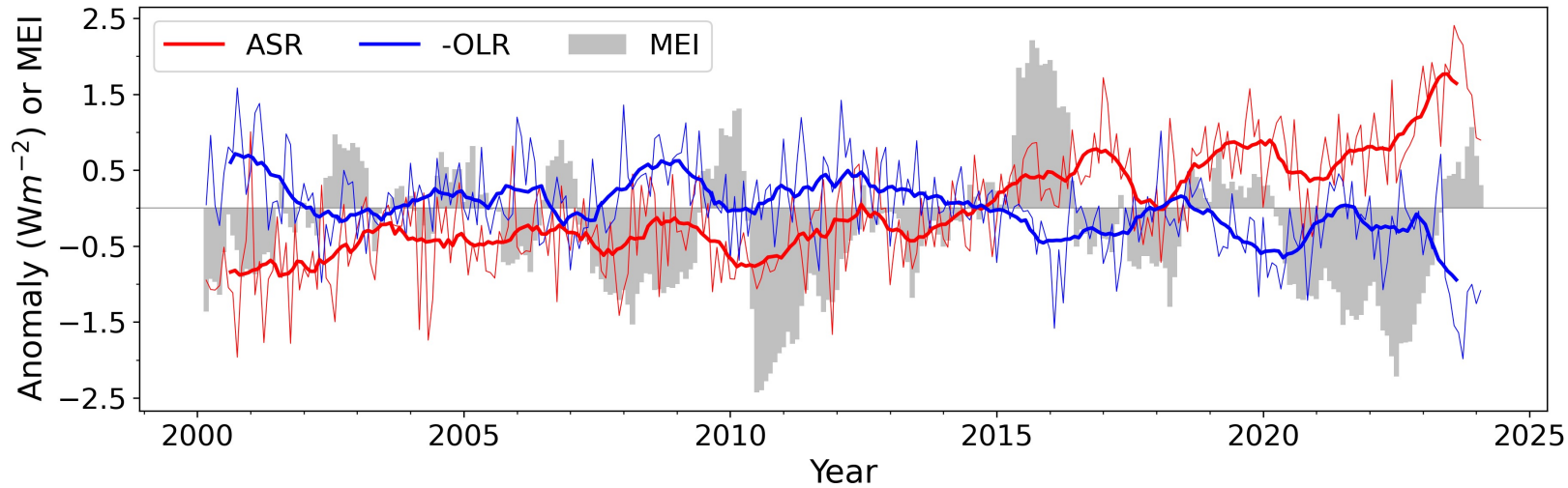
CERES Science Team Meeting, May 14-16, 2024
NASA Langley Research Center, Hampton, VA

CERES Technical Meeting

Review Status of CERES Instruments and Data Products:

- State of CERES
- CERES Terra, Aqua, S-NPP, NOAA-20 Instrument Calibration Update
- MODIS & VIIRS Cloud Algorithm & Validation Status
- ADM, SARB and TISA Working Group Reports
- EBAF-SFC Update
- FLASHFlux Update
- Data Management Team Update

Global Mean All-Sky TOA Flux Anomalies (CERES EBAF Ed4.2; 03/2000–02/2024)

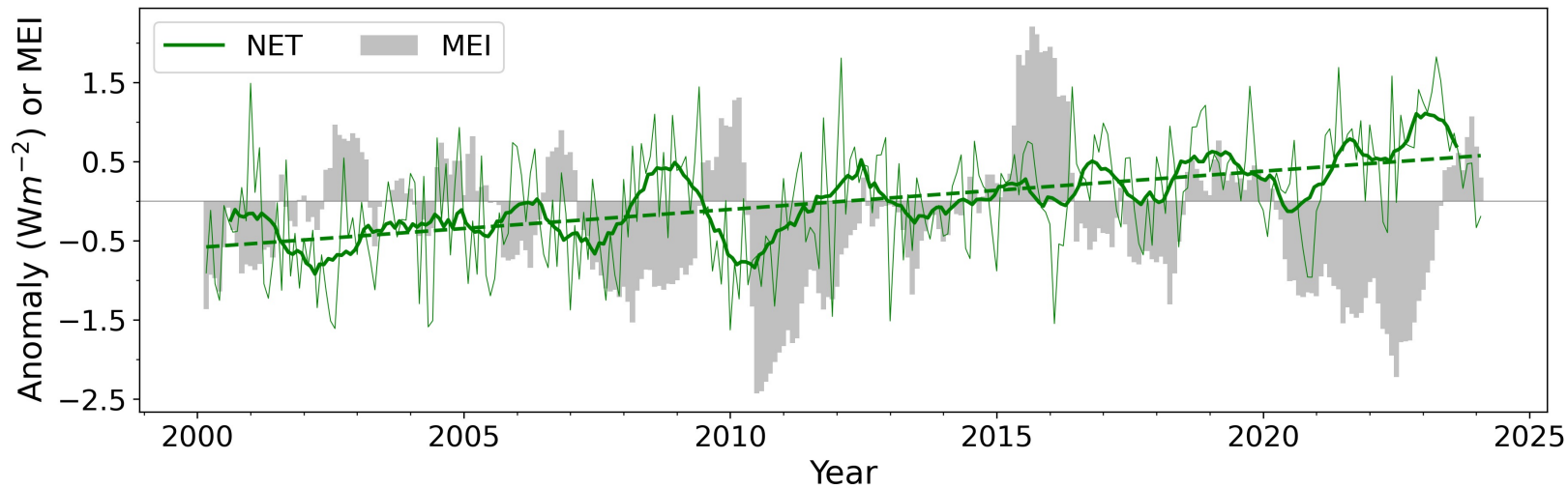


Trends (Wm^{-2} per decade; 2.5-97.5% CI)

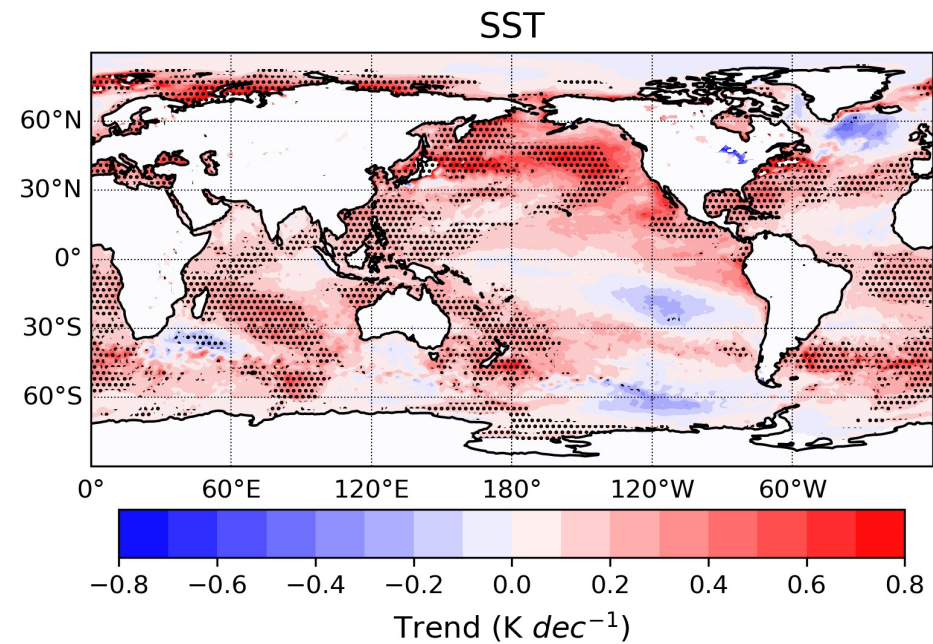
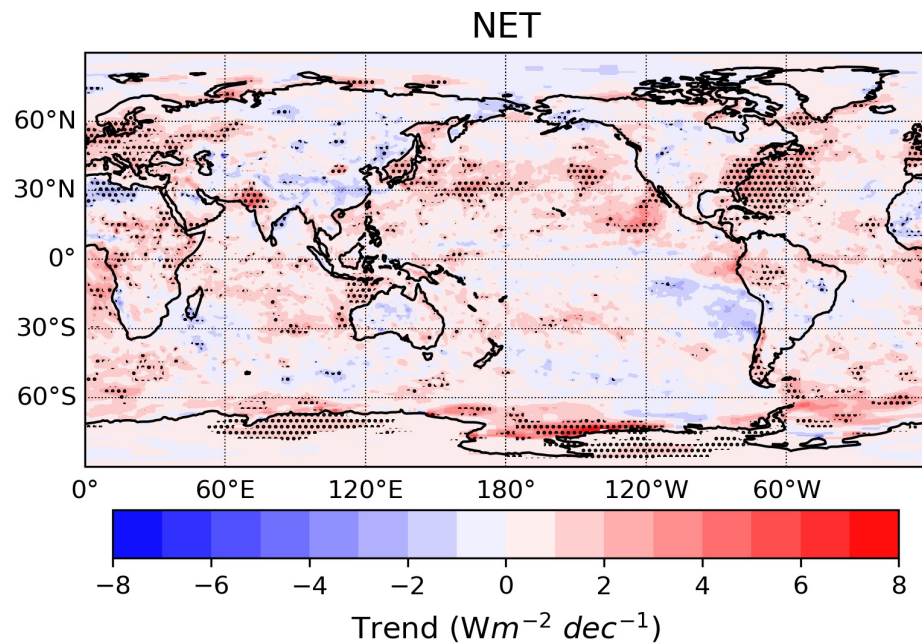
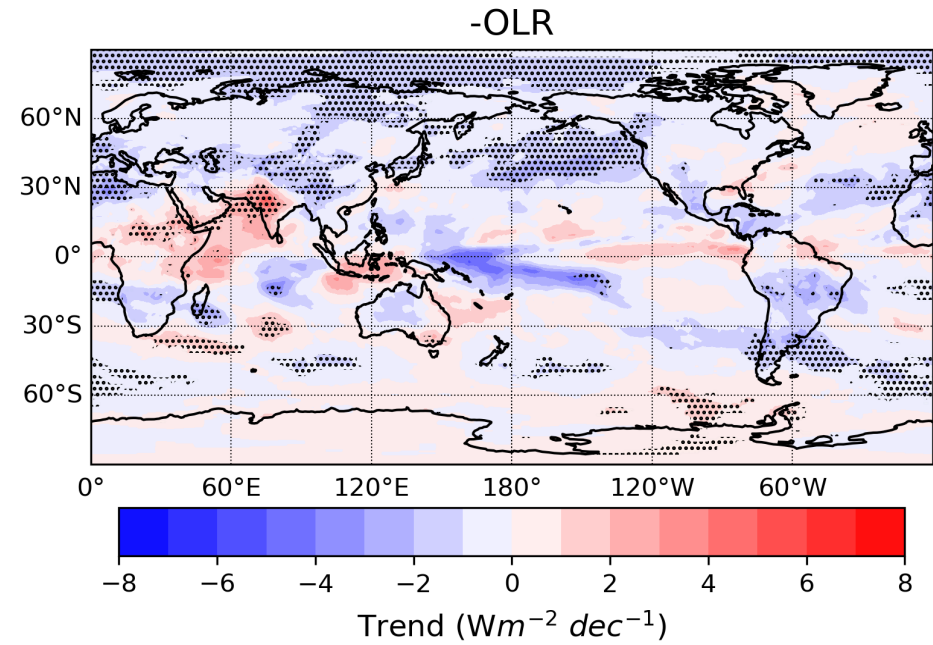
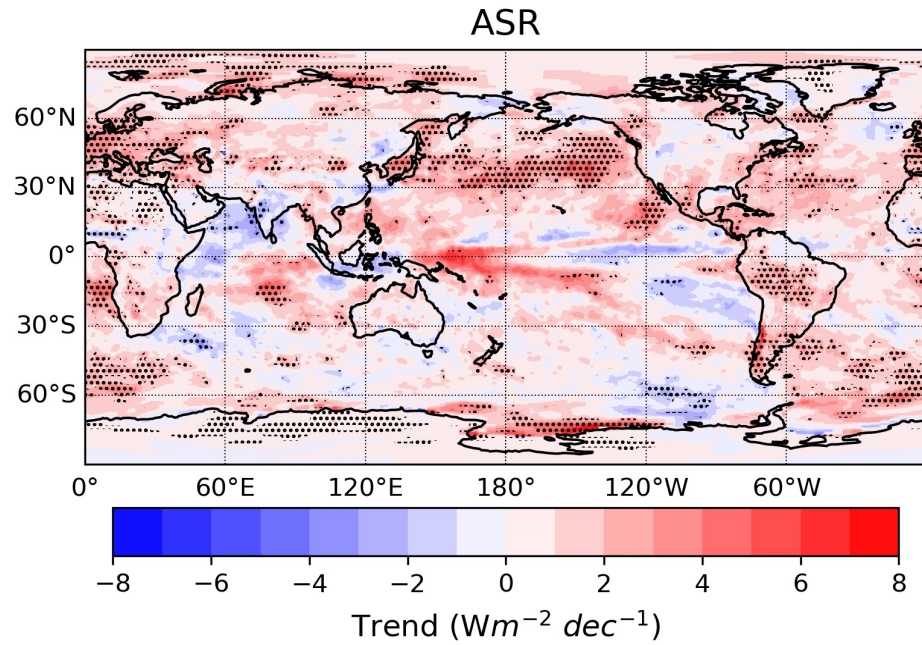
ASR: 0.82 ± 0.22

-OLR: -0.33 ± 0.19

NET: 0.48 ± 0.18

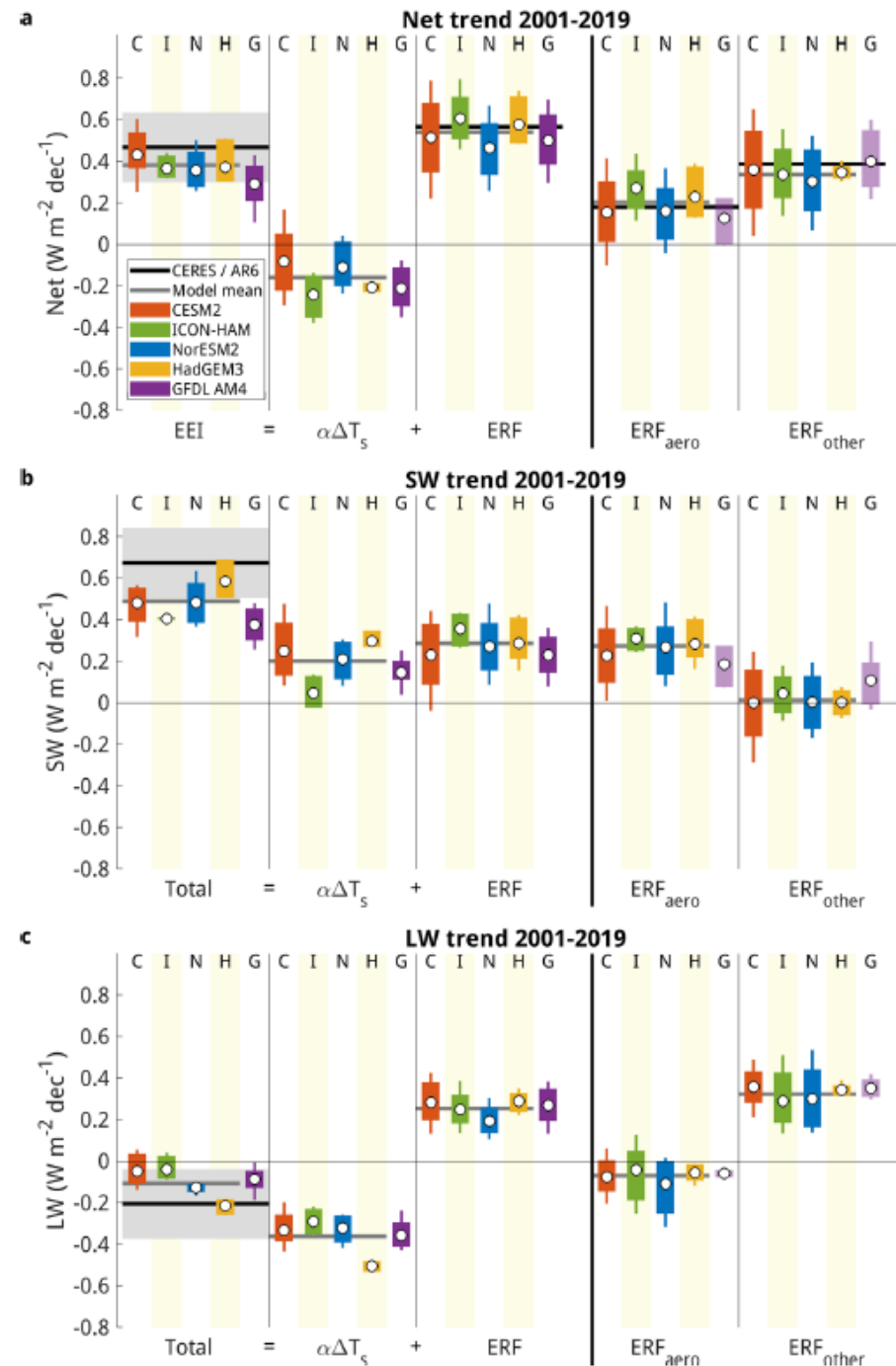


Regional Trends in TOA Radiation and SST (03/2000–02/2024)



CERES EI Trend Attribution

- CMIP6 AMIP Simulations
- Forcing-feedback framework



Key Points

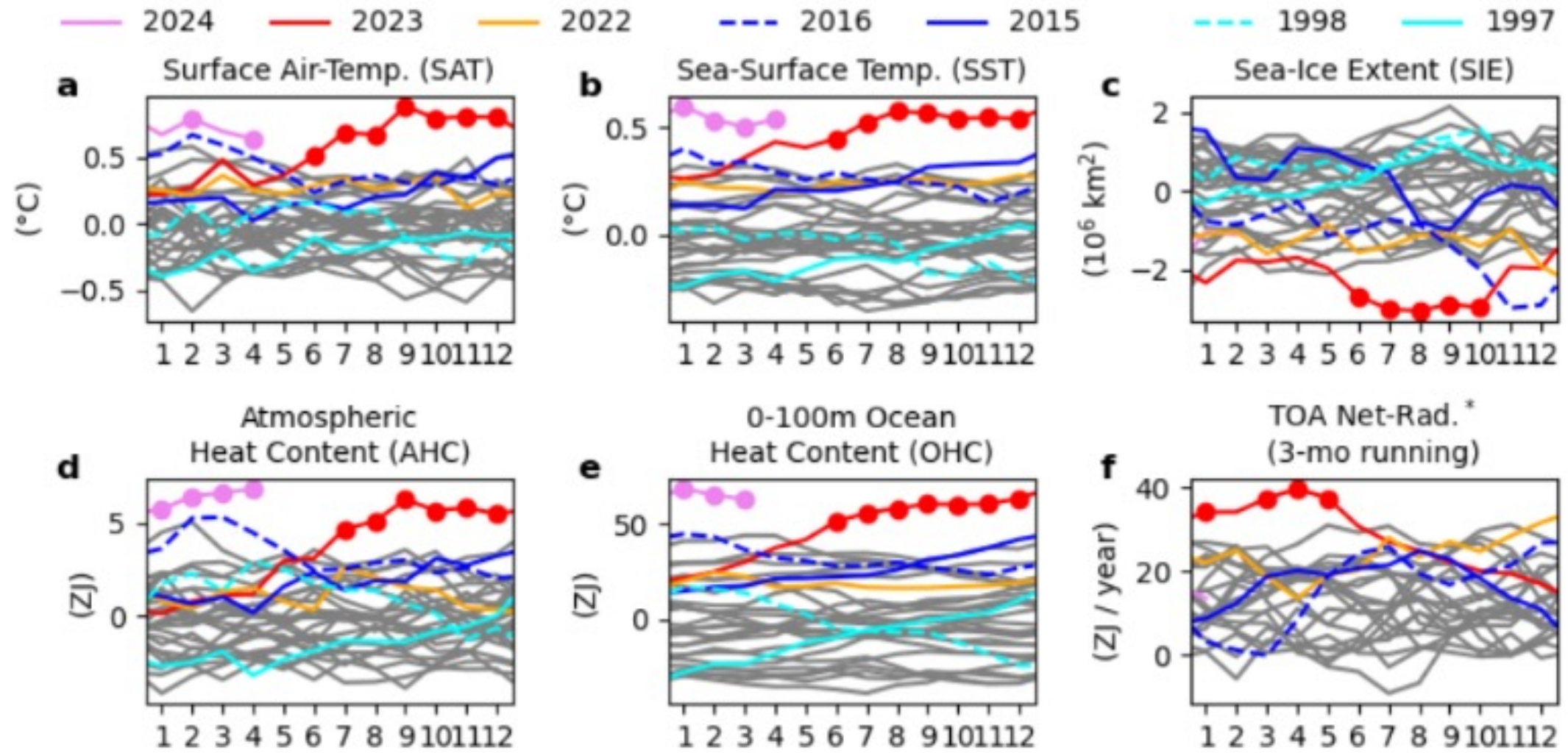
- CMIP6 EEI trend consistent with CERES within uncertainty
- ERF contribution dominates (WMGG, aerosols)

- Large CERES ASR trend due to additive positive ERF and feedback contributions
- Models suggest large aerosol forcing

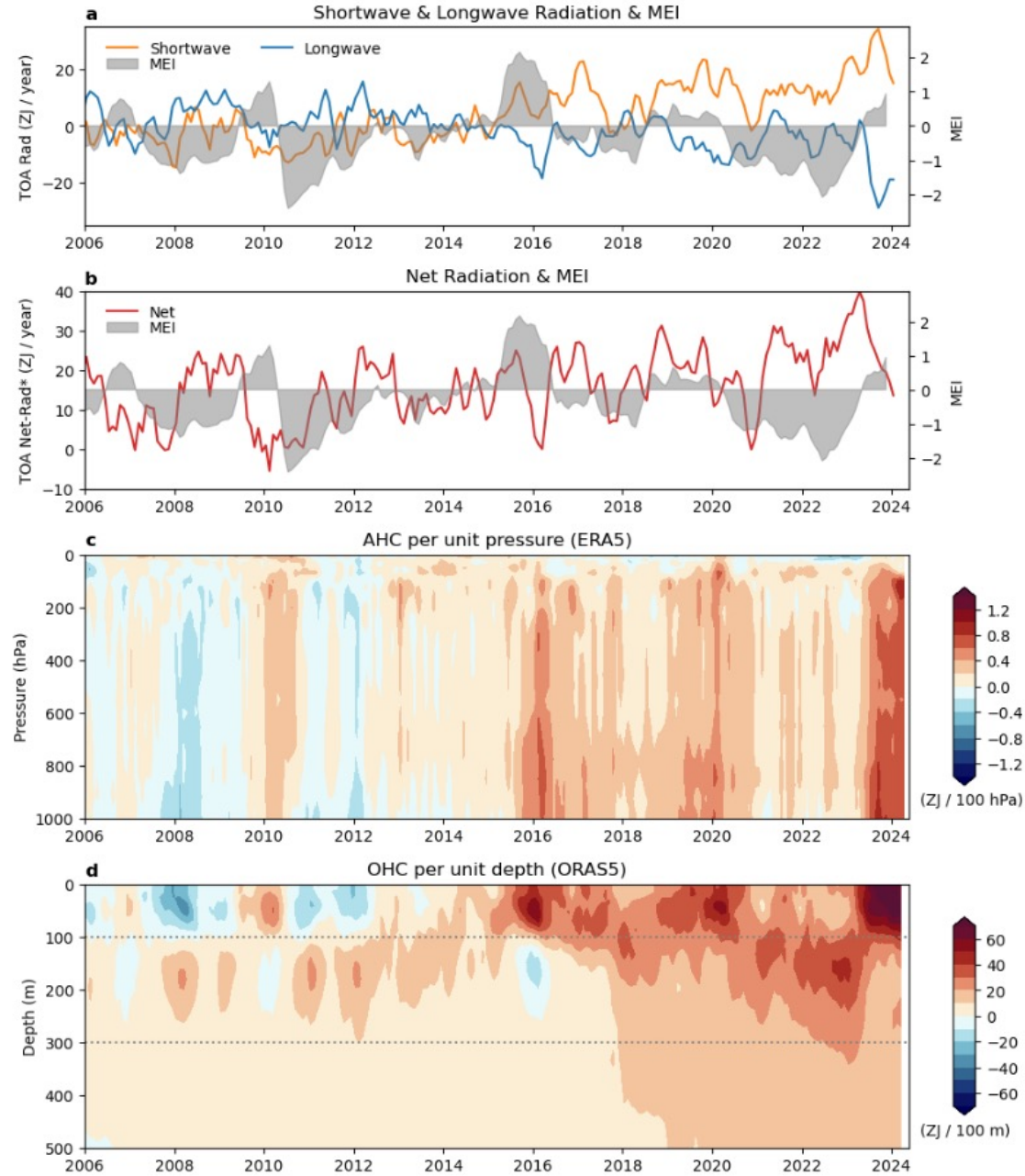
- Weaker OLR trend due to cancellation between positive ERF and negative feedback contributions

Monthly Values of Anomalies for Various Global Climate Indices

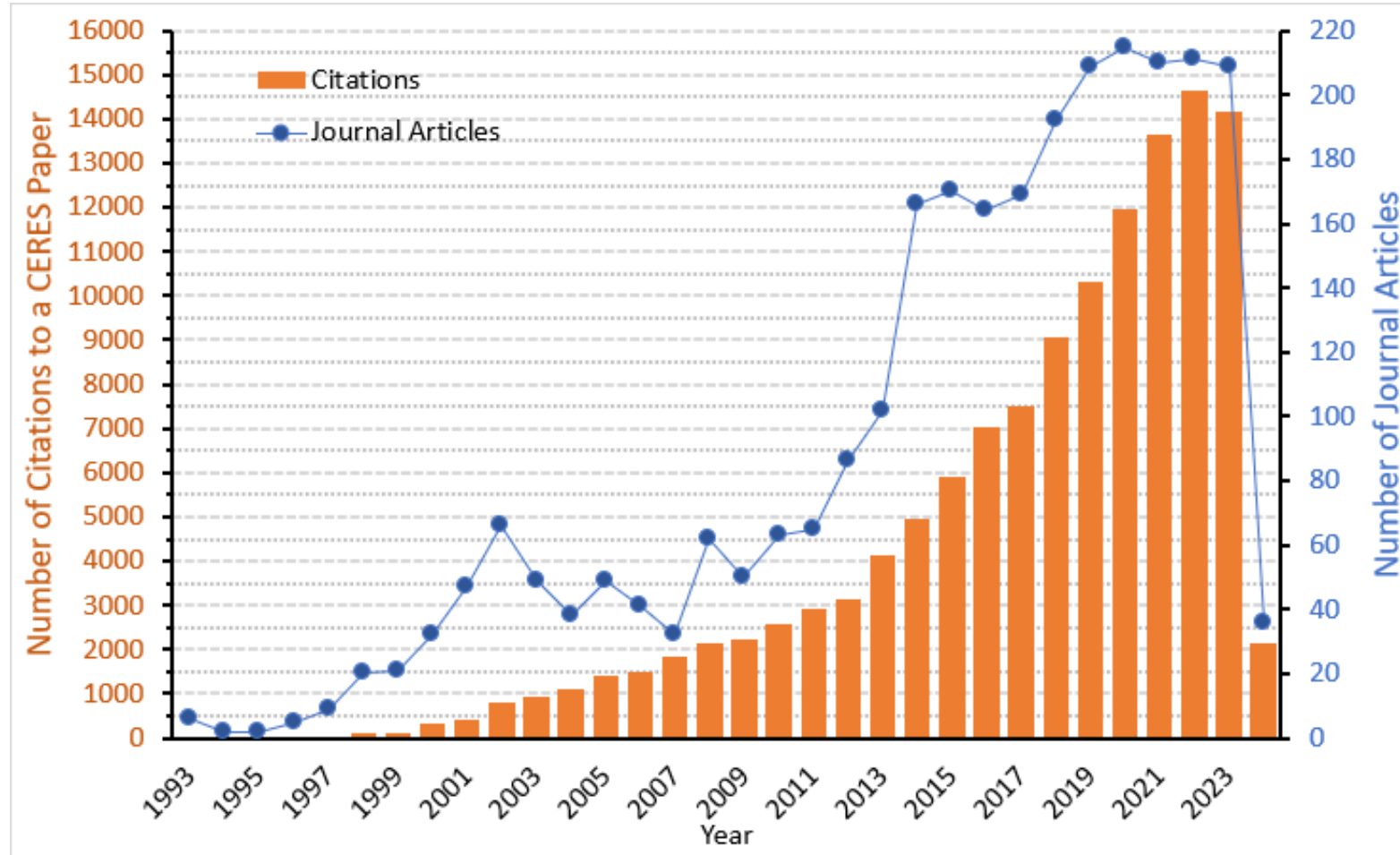
(Figs a-e: Climatology for 1993-2022; Fig. f: Climatology for 2000-2022)



Global TOA Radiation, Atmosphere & Ocean Heat Content Evolution



CERES Journal Publications and Citation Counts (For Papers Between 1993-2024; Updated March 25, 2024)



- Total number of peer-reviewed journal articles: 2,798
- Total number of citations to CERES papers: 127,171

(Compiled by Dennis Keyes)

Number of Unique Users by CERES Data Product

(through April 30, 2024)

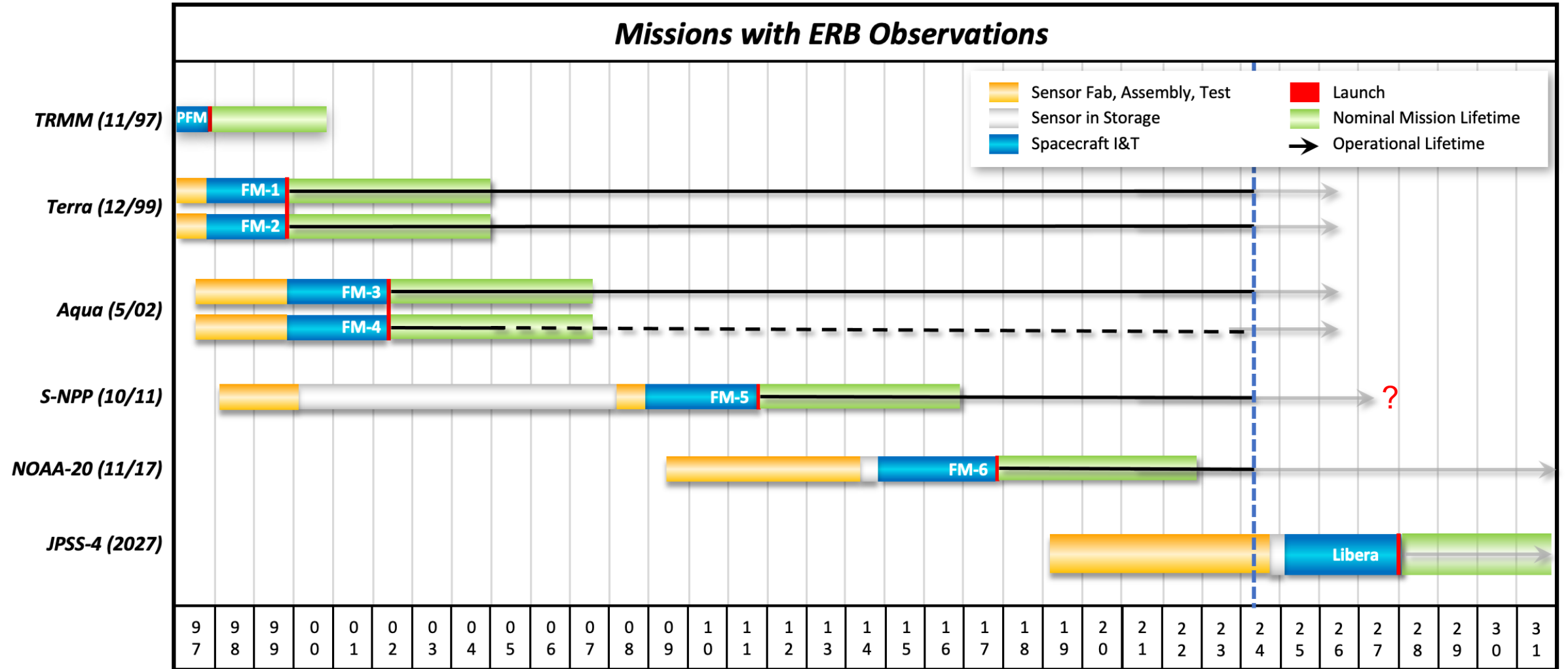
Level	Product	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
1b	BDS	11	13	14	10	12	23	29	31	14	8
2	SSF	253	278	327	235	251	245	266	272	276	99
	CCCM	55	54	49	49	36	45	58	64	75	13
	ES8	21	15	15	10	8	11	12	14	11	13
3 & 3b	EBAF	787	783	935	928	995	1041	1055	1202	1570	637
	SYN1deg	438	494	607	639	754	854	886	923	973	408
	SSF1deg	160	194	190	159	221	213	226	261	177	90
	CldTypHist	40	47	86	87	79	86	94	83	116	41
	FluxByCldTyp						50	69	67	93	24
	ES4	13	12	17	17	17	11	17	16	15	6
	ES9	5	5	8	6	6	8	5	9	5	2

FLASHFlux via POWER since last year: **150K**

CERES Formal Reviews

- LaRC SD Peer Review – November 29-30, 2023
- SMD Triannual Status Meeting – December 7, 2023
- Independent Review Team (IRT) Evaluation of RBSP – January 25-26, 2024
- SMD Triannual Status Meeting – March 13, 2024
- RBSP-Libera dPMC – March 22, 2024
- PPBE-2026 Review – May 3, 2024

Flight Schedules

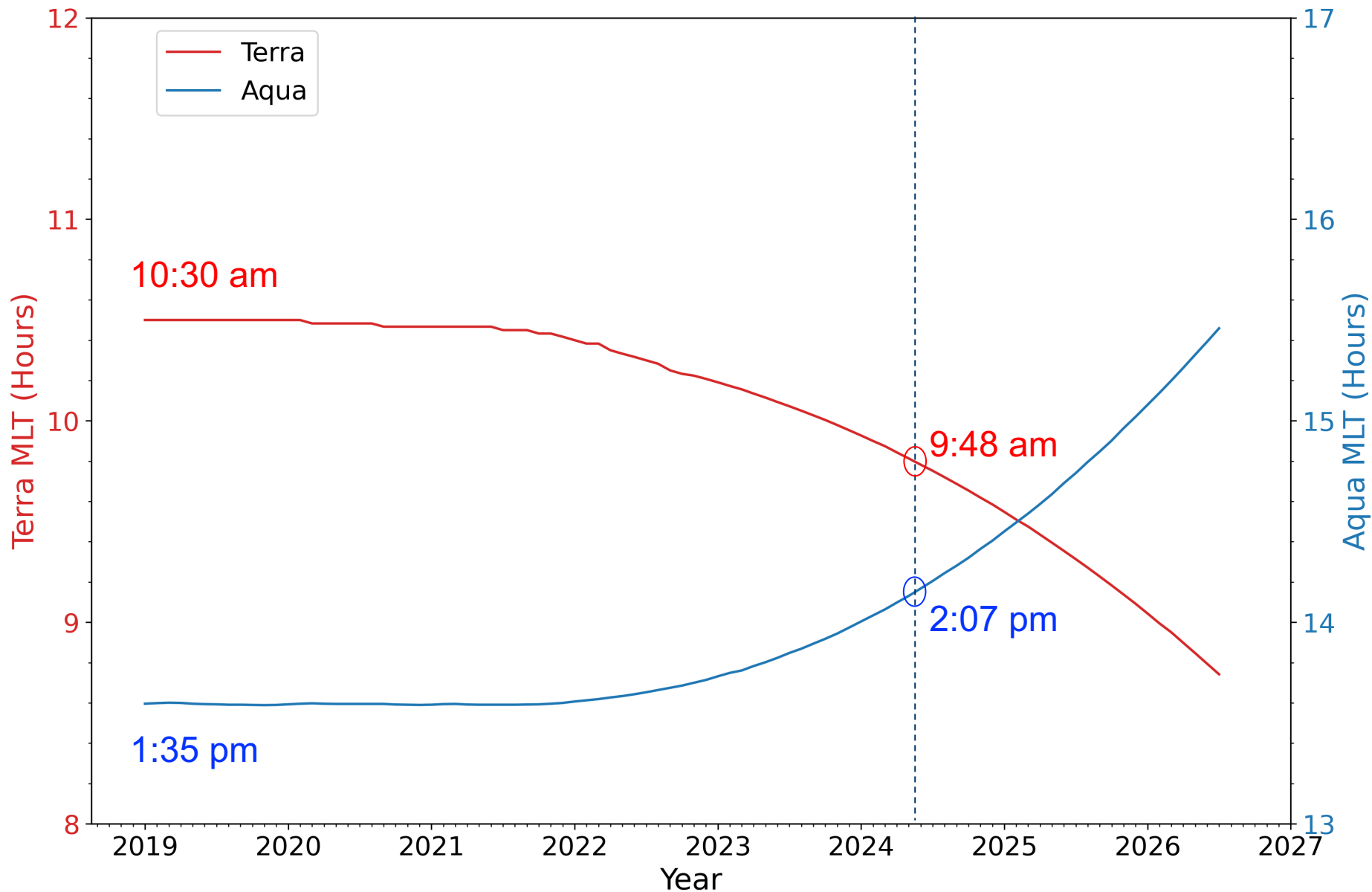


- Currently, 6 CERES instruments fly on 4 satellites: Terra (L1999), Aqua (L2002), SNPP(L2011), NOAA-20 (L2017)
- Libera scheduled for launch in 2027 on JPSS-4

Status of CERES Instruments on Terra, Aqua, S-NPP and NOAA-20

- 2023 Senior Review recommended extending Terra and Aqua for another 3 years
 - Anticipate end of science data collection in the latter part of 2026
- End date of S-NPP is unknown. Ongoing topic of discussion between NASA and NOAA
- CERES FM6 SW channel exhibited increased noise between November 2023-February 2024
 - Tiger team assembled to determine root cause
 - Problem appears to have subsided in recent months
 - More details provided in the Instrument Working Group Report (next presentation)

Terra and Aqua Mean Local Equatorial Crossing Times (MLTs)



• MLT updates available at: <https://terra.nasa.gov> & <https://aqua.nasa.gov>

Libera, NASA Earth Venture Continuity-1 Mission



Provides continuity of the Clouds and the Earth's Radiant Energy System (CERES) Earth radiation budget (ERB).

- Measures integrated shortwave (0.3–5 μm), longwave (5–50 μm), total (0.3–100+ μm) and *(new) split-shortwave (0.7–5 μm) radiance* over 24 km nadir footprint; *uncertainty $\sim 0.3\%$*
- *Includes a wide FOV camera for scene ID and simple ADM generation*

Innovative technology:

- *Electrical substitution radiometers (ESRs) using vertically-aligned carbon nanotube (VACNT) detectors*

Primary operational modes:

- Cross-track and azimuthal scanning; on-board calibrators; solar and lunar viewing.

Flight:

- JPSS-4, 2027 launch; 5-year mission

Partners:

- LASP, Ball Aerospace, NIST Boulder, Space Dynamics Lab; CU, JPL, CSU, UA, UM, LBL

Libera Major Reviews and Key Milestones

Milestone	Acronym	Date	Convening Authority
Authorization to Proceed	ATP	6 Jul 20	-
System Requirements Review	SRR	22 Feb 21	SRB
Key Decision Point - B	KDP-B	30 Apr 21	SMD PMC
Preliminary Design Review	PDR	8-10 Feb 22	SRB
Key Decision Point - C	KDP-C	Apr 22	SMD PMC
Critical Design Review	CDR	27-29 Jun 23	SRB
Libera Accommodations Review	LAR	15-16 May 24	JPSS
Pre-Environmental Review	PER	Mar 25	SRB
Pre-Ship Review	PSR	Sep 25	SRB
Delivery to Spacecraft		Sep 25	-
Key Decision Point D	KDP-D	Nov 25	SMD PMC
Launch		2027	-
Key Decision Point E	KDP-E	2027	SMD PMC
Post Launch Assessment Review	PLAR	L+90d	SRB
Operational Transition Review	OTR	PLAR + 9mo	TBD

Planning for CERES Edition 5

- 1) GMAO improvements to atmospheric reanalysis system.
 - CERES and GMAO hold Teams meetings every 3 weeks to gauge progress and provide ongoing validation results for GEOS-IT.
 - GEOS-IT reprocessing is up to date.
- 2) MODIS Collection 7. Release date for MODIS Level-1b is unknown. Requires approval by members of higher-level products.
- 3) CERES production code improvements.
- 4) CERES algorithm improvements (particularly those enabling a seamless transition across satellite platforms).

CERESMIP

- The Coupled Model Intercomparison Project (Phase 6) (CMIP6) protocol only uses observed forcings to 2014.
- However, climate variability since 2014 is quite pronounced and scientifically interesting (e.g., EEI and SST trends, PDO shifts, 2015/2016 El Nino, Marine Heat waves, etc.).
- In addition, many of the model inputs have been updated substantially since the CMIP6 inputs were defined.
- So why hasn't there been a coordinated effort to update climate model AMIP simulations?
- Gavin Schmidt (NASA GISS) is leading a new, relatively low cost, model intercomparison, CERESMIP, that will focus on the CERES period, with updated forcings to the end of 2021.
- The focus will be on atmosphere-only simulations, using updated SST, forcings and emissions from 1990-2021.
- The diagnostic focus will be on the EEI and atmospheric feedbacks, and so diagnostics should include output from the COSP simulator.
- A journal article describing CERESMIP has been published. <https://doi.org/10.3389/fclim.2023.1202161>
- New WCRP lighthouse activity on Explaining and Predicting Earth System Change (EPESC) with a focus on Earth's Energy Imbalance has been established.

Upcoming Conferences & Meetings of Interest

International Radiation Symposium

- June 17-21, 2024, Hangzhou, China

Fall 2024 CERES Science Team Meeting

- Oct 1-3, 2024, Lawrence Livermore National Laboratory, Livermore, CA

Fall AGU

- December 9-13, 2024, Washington, DC

AMS Annual Meeting

- January 12-16, 2025, New Orleans, LA